Agricultural carbon markets: Opportunities and challenges for Sub-Saharan Africa

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Contents

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Executive summary

Emissions from agriculture contribute approximately 14% of global greenhouse gas (GHG) emissions and are expected to rise by 38% over the period 1990-2020. In developing countries emissions from agriculture are a significant, sometimes the primary, source of national emissions. For example, in Africa 43% of total CO2 emissions originate from land clearing for agricultural use and a further 316 billion tonnes of CO2eq are stored in top soils at risk from degradation.

Failure to tackle emissions from agriculture will not only undermine national efforts to tackle climate change but will hinder global efforts to keep increases in temperature to 1.5-2 degrees Celsius by the end of the century. Solutions to agricultural emissions are needed.

Climate-smart agriculture (CSA) can help reduce emissions by sequestering carbon in trees and soils, and by reducing emissions from other sources such as land degradation, livestock and inefficient fertiliser use. At the same time CSA can help agriculture adapt to the impacts of climate change and increase productivity (and thus food security, farmer income and agribusiness profit). CSA represents a 'triple win': mitigation, adaptation and productivity.

Some progress has been made in scaling up the adoption of CSA practices but progress is held back by a lack of knowledge, land and natural resource tenure issues, and capacity and capital constraints. CSA has also received insufficient attention in the international climate negotiations.

Public funding alone cannot address the scale of the CSA challenge. Carbon markets have the potential to inject much needed financial capital into CSA, as well as enabling routes to market, skills and innovation. But what is the potential of carbon markets to support CSA? Are compliance or voluntary carbon markets best? Do existing carbon methodologies support practices with the greatest potential to deliver a 'triple-win' of mitigation, adaptation and productivity benefits? And within the voluntary market, which standards provide the best combination of credit value, volume of sales and reputation, with a pragmatic approach to CSA project developer needs?

This report attempts to answer these questions through an assessment of the opportunities and challenges relating to agricultural carbon markets with particular reference to Sub-Saharan Africa. The report includes an assessment of the size and scope of the carbon market for CSA, the existence of carbon methodologies to support adoption of CSA in Sub-Saharan Africa, and the attractiveness of different carbon market standards.

The report found a growing interest in agricultural carbon that is being translated into new projects and methodologies, in particular in the voluntary carbon markets. And it found opportunities for different approaches to methodology development and monitoring techniques, such as Programme of Activities (PoA), grouped and standardised approaches, and activity based monitoring approaches. But overall agricultural carbon markets are nascent, held back by a number of barriers including the ineligibility and unattractiveness of CSA credits, the technical complexity and lack of availability of carbon methodologies, and high transaction costs relating to monitoring, reporting and verification (MRV) of agricultural carbon when compared to current market prices.

CSA practices with the potential to deliver 'triple win' benefits have greater eligibility in the voluntary rather than compliance carbon markets, however none of the primary standards currently used within the voluntary market, meet all of the criteria required to support project development at scale: broad eligibility of CSA practices (including soil carbon management), investor demand, sufficient value of credits, strong reputation for environmental integrity of credits, and a pragmatic approach to project developer needs. Furthermore, given the significance of adaptation and productivity benefits relative to mitigation, mechanisms for CSA projects to benefit from 'non-carbon market' climate finance opportunities are likely to be required.

If carbon markets are to fulfil their potential for supporting the scaling up of CSA activities then three changes are needed:

- First, a wider range of CSA activities needs to become eligible in both compliance and voluntary carbon markets;
- Second, more methodologies are needed that support 'triple-win' CSA practices; and
- Third, the technical burden of carbon project development needs to be reduced.

This could be achieved through increasing uptake of programmatic approaches to project development, standardised approaches to baseline and additionality assessment, and increased use of activity based monitoring methods underpinned by regionally specific field research. These changes would help to make carbon markets work for agriculture and could make a substantial contribution to poverty alleviation in Sub-Saharan Africa, especially if combined with other sources of climate finance.

Even so, in the absence of strong demand for carbon credits underpinned by legally binding emissions reduction commitments, the potential of CSA will continue to be held back.

Part one: Opportunities and challenges

Two of the greatest challenges facing humanity at the start of the 21st century are the increasing demands of a growing population and climate change. Agriculture is critical to both, perhaps nowhere more so than in Sub-Saharan Africa.

The population of Sub-Saharan Africa is estimated to rise from 770 million in 2005 to 1.5-2 billion by 2050[1] . Currently 30% of the population in Sub-Saharan Africa remains undernourished[2]. Feeding an expanding population represents a serious challenge and will require significant increases in agricultural yields. Much of this yield increase will have to come from productivity increases in smallholder farming systems of 2 hectares or less, of which there are currently 33 million, representing 80% of all farms in the region.

At the same time the impacts of climate change are projected to threaten the resilience and productivity of African farming systems. These impacts, which include long term changes in temperature, rainfall and increasingly erratic weather patterns, will particularly impact smallholder rain-fed systems. For example the IPCC Fourth Assessment Report[3] warns that net revenues of some crops are likely to fall by as much as 90% by 2100 in the South African region, with smallholder farmers being the most severely affected.

There is an urgent need to transform agricultural systems to improve productivity and reduce variability in crop yields in the face of these two challenges. Such transformations can be supported by the adoption of climate-smart agricultural (CSA) practices, which will involve changes in natural resource management (including land, water and soil nutrients)[4]. Of the different CSA practice types, those with the greatest adaptation and productivity benefits include: agroforestry (including the use of nitrogen fixing species); watershed management; residue and tillage management; and nutrient management[5].

In addition to enhanced productivity and adaptation benefits, CSA could deliver substantial mitigation benefits through enhancing carbon sequestration in trees and soils, and by reducing emissions per unit of output. Those with the greatest mitigation potential include: agroforestry; pasture and grazing land management; and watershed management.

In Africa, where 316 billion tonnes of CO2eq is stored in top soils and 43% of total CO2 emissions originate from land clearing for agricultural use, CSA represents a significant opportunity to contribute to global mitigation efforts[6].

The FAO define climate-smart agriculture as: 'Agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievement of national food security and development goals'

[1] FAO.2009. The special challenge for Sub-Saharan Africa.
[2] FAO.2009. Food security and agricultural mitigation in developing countries: options for capturing synergies.
[3] Boko, M et al.2007. Africa. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change
[4] FAO. 2010. Climate-Smart Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation.
[5] For more details of these individual practices please refer to the CSA factsheets produced by PwC for the Rockefeller Foundation
[6] TerrAFrica.2009. Sustainable Land Management in Africa: Opportunities for Increasing Agricultural Productivity and Greenhouse Gas Mitigation

The importance of private finance for CSA in Sub-Saharan Africa

Private finance is essential for the success of CSA adoption in Sub-Saharan Africa. The FAO has estimated that gross investment of USD 940 billion is needed in the Sub-Saharan agricultural sector between 2007 and 2050 if the region is to meet long term demand for agricultural products[7]. This equates to an average annual capital requirement of USD 21 billion; however the reality is that much of this investment will need to be frontloaded in the earlier years and decades.

Currently 30% of agricultural finance in developing countries comes from public sector sources (both 'official development assistance' and domestic), with a larger portion of investment coming from private sources (both domestic and foreign)[8]. On the assumption that this public-private share continues, an average of USD 15 billion per annum of investment will need to come from private sources.

The scale of finance required for agriculture in Sub-Saharan Africa puts the need for private sector finance beyond doubt. But it is not just finance that is needed from the private sector. Innovations in technology, for example in the development of climate resistant crop varieties, are needed too. Agriculture will also need to draw on the strengths of the private sector in the provision of goods and services, such as seeds, tools, and fertiliser, the training of workers, communicating with consumers, creating markets for products, and insuring business activities.

The success of CSA in Sub-Saharan Africa depends on reorienting private sector investment and activity towards support for adoption of CSA practices amongst smallholders. As such CSA and the associated policy and regulatory frameworks need to provide appropriate incentives to the private sector to change existing business strategies and practices that encourage or accelerate unsustainable agricultural practices, as well as to invest in new strategies and practices, supporting 'green growth' and generating 'green jobs' through the adoption of CSA practices.

This transformation in private sector activity will need to embrace companies and businesses of all sizes, in a wide range of sectors, not just in Sub-Saharan African nations: for example, retail and consumer goods companies elsewhere in the world that create much of the demand for agricultural commodities, and investors and banks that provide the finance for these activities.

[7] FAO. 2009. Capital requirements for agriculture in developing countries to 2050.
[8] ibid

Carbon markets play an important role in catalysing the private sector

Carbon markets can be a powerful policy instrument to leverage private capital for green growth, including CSA activities. Carbon markets put a price on carbon which helps stimulate abatement and technology transfer and drive investment in low carbon technologies and services. This price signal assists in the identification of low cost abatement opportunities (e.g. energy efficiency measures), reducing the overall global cost of mitigation. Appropriately designed carbon markets have the potential to drive private sector investment at scale within the agricultural sector, underwriting the training of farmers in new practices, the provision of inputs such as seeds and fertiliser, and the establishment of MRV systems to track carbon and agricultural benefits that accrue.

Table 1: The benefits of carbon markets and emissions trading

Global	Obligated emitters	Developing countries
• Guarantee of environmental outcome, assuming proper design and enforcement • Requirement for emitters to measure, report and verify emissions • Creation of price signal to stimulate mitigation activities • Lowers overall cost of mitigation	• Lower costs of compliance • Opportunity for profit through over-compliance	• Support for green growth through inward investment in low carbon technologies and services • Stimulation of technology transfer • Income for smallholders and farming communities

Carbon markets need to have breadth, robust caps, liquidity and transparency if they are to be fully effective. In addition, because carbon credit instruments are commodities created by intergovernmental agreements and by national or local government policies, market participants need policy 'TLC' – transparency, longevity and consistency.

In their design, carbon markets support identification and prioritisation of emissions reduction activities that are low in cost and with low barriers to implementation, i.e. the 'low hanging fruit'. However, the mitigation potential of CSA at the individual smallholder level is relatively low. Estimates vary but are considered to be between -0.79 - 8.51 tCO2 / year / hectare[9]. To realise significant emissions reductions, aggregation is required across tens of thousands of smallholders and this in turn increases transaction costs. This in part explains why emissions reductions from smallholder agricultural systems have, to date, often been overlooked within the market.

The unattractiveness of CSA projects has been compounded by a lack of knowledge of CSA, capital and capacity constraints, a lack of recognition of CSA in international climate change negotiations, ineligibility of CSA projects in compliance markets, gaps in available carbon methodologies and land and natural resource tenure issues.

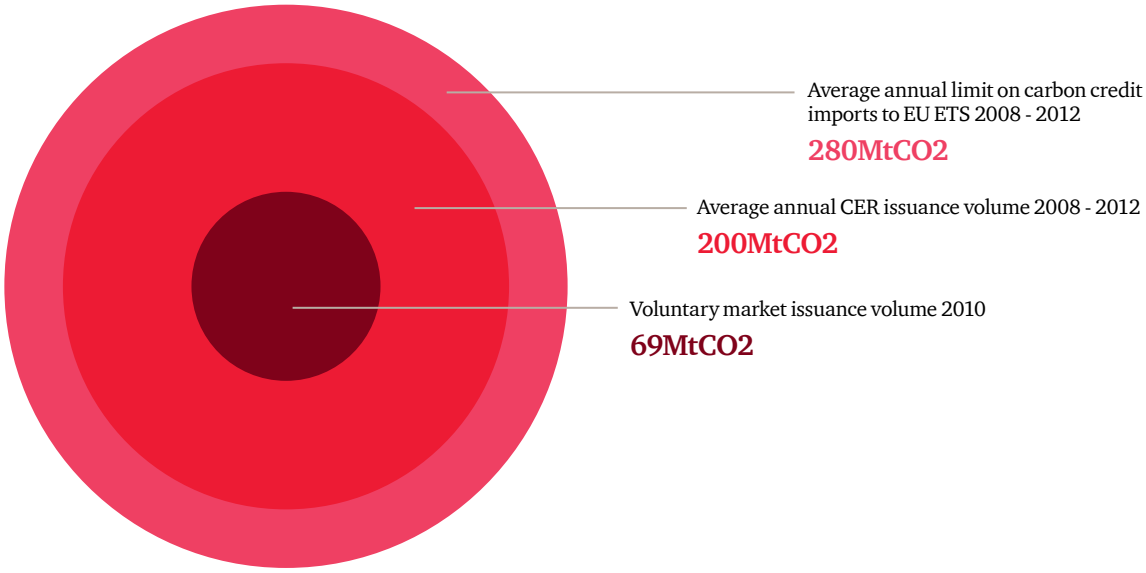
Despite these barriers a number of carbon methodologies have emerged for agriculture and agricultural credits are being traded in carbon markets, albeit with limitations. Part Two of the report explores the extent to which compliance and voluntary carbon markets support CSA and whether existing methodologies support practices with the greatest potential to deliver a 'triple-win' of mitigation, adaptation and productivity benefits.

[9] Smith et al. 2007. Agriculture. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

Part two: Overview of agricultural carbon markets and methodologies

The carbon market is made up of a number of different carbon markets including project based carbon credits under the Clean Development Mechanism, emissions trading schemes and the voluntary carbon market. Different carbon markets vary in size, in terms of total issuance volumes and the scope for use of credits:

Figure 1: Overview of 2010 global carbon market [10,11,12]



[10] The total volume of OTC transactions (excluding those on the Chicago Climate Exchange which ceased trading at the end of 2010) in the voluntary market was 69 MtCO2 in 2010. Bloomberg New Energy Finance, Ecosystem Marketplace, 2011. Back to the Future: State of the Voluntary Carbon Markets 2011

[11] The total CER issuance between 2008-2012 is anticipated to be approximately 1.2 GtCO2.Various sources cited in: World Bank, 2011. State and trends of the carbon markets.

[12] The annual EU ETS CER / ERU import limit for phase II (2008-2012) is 280 Mt CO2. This represents approximately 13% of the total cap of the EU ETS. http://www.pewclimate.org/docUploads/EU-ETS-In-Perspective-Report.pdf, http://ec.europa.eu/clima/policies/ets/cap/index_en.htm

Clean Development Mechanism

The principles of both emissions trading and project based carbon credits were established by the 1997 United Nations Kyoto Protocol. The Protocol is a binding legal agreement under which developed countries accepted targets for limiting or reducing greenhouse gas (GHG) emissions. Countries with targets were given an assigned amount of emissions units for the period 2008-12. Those countries with surplus units during that period can sell them to those with a shortfall.

The main 'project based mechanism' which the Protocol established was the Clean Development Mechanism (CDM), credits from which are designated as Certified Emission Reductions (CERs). The CDM seeks to encourage low carbon investment and sustainable development in developing countries by permitting industrialised countries or companies to finance GHG emissions reduction projects in those countries in return for offset credits.

The volume of CDM activity in the primary market grew strongly over the period 2005-2007, to a peak in 2007 of $7.4 billion, but has subsequently declined, with the 2010 primary CDM market valued at $1.5 billion[13]. In contrast, the annual value of trading in secondary CERs has stabilised in recent years at around $18 billion, from a peak of $26.3 billion in 2008.

The current CDM pipeline shows 6,416 projects which have to date issued 638 MtCO2eq of emission reductions and are expected to deliver over 2 BtCO2eq of emission reduction by the end of 2012[14]. With regards to land use, land use change and forestry (LULUCF) activities, the Kyoto Protocol limits eligible CDM activities to afforestation and reforestation (A/R), and even then awarding only temporary credits that have limited fungibility with other traded carbon credits. Agricultural soil carbon management in croplands and grassland, avoided deforestation and avoided forest degradation mitigation activities remain ineligible under existing CDM regulation.

These factors, combined with the ineligibility of A/R credits within the EU Emissions Trading Scheme (EU ETS), have resulted in only 21 A/R CDM projects developed and successfully registered as of July 2011. CSA has largely therefore been excluded from the CDM which has in turn limited the extent to which Sub-Saharan Africa, and in particular the rural poor, have been able to benefit from carbon markets.

The focus of the CDM on industrial and energy sectors has also been a challenge for Sub-Saharan Africa. Indeed, the current CDM pipeline shows just 168 projects (2.6% of the total) located in Africa, of which only 99 are in Sub-Saharan African countries (excluding South Africa)[15]. Of the 168 African projects in the CDM pipeline in Africa, 28 are landfill activities, 24 biomass energy, 19 wind energy and only 4 A/R projects[16].

[13] Ibid.
[14] UNEP Risoe CDM/JI Pipeline Analysis and Database. 1 July 2011
[15] ibid
[16] ibid

Clean Development Mechanism

Registered CDM methodologies and their applicability to CSA in Sub-Saharan Africa

Of the existing registered CDM methodologies, few have been developed with the needs of Sub-Saharan African smallholder farmers in mind. Our review[17] of existing CDM methodologies identified 40 that have potential linkages to implementation of CSA practice types. These are predominately[18] related to:

- Watershed restoration: either directly through A/R activities, or indirectly through integrated farm energy systems/energy efficiency activities that could alleviate non-renewable firewood collection pressures;
- Agroforestry systems: including both intercropping and silvopastoral activity types;
- Integrated farm energy systems: largely through production of biomass residue, renewable biomass, and plant oil for biodiesel production; and
- Livestock management: largely through manure management and associated methane avoidance.

Of these methodologies few can be regarded as highly applicable to smallholder farmers in the Sub-Saharan Africa region. This is due to a combination of:

- Restrictive eligibility requirements: for example several CDM A/R methodologies restrict movement of activities such as cropping, grazing and firewood collection from the project site;
- Unsuitable technology requirements for adoption by smallholder farmers in the regional context;
- The limited ability of smallholder farmers to negotiate long term contracts (including carbon revenue sharing arrangements); and
- Lack of links to centralised power generators, biodiesel producers and/or manure treatment plants. There is also limited capability to set up these operations in co-operative groups.

In addition, few of the practices to which these methodologies could be applied to have potential to deliver direct adaptation or productivity benefits, which are a greater priority for smallholders than mitigation. Exceptions include methodologies with linkages to watershed restoration and agroforestry activities types.

The role of Programmes of Activities

Programmes of Activities (PoA) is a modality for project development under the CDM. It was conceived to help replicable project activities with low and geographically disbursed emission reduction potential, overcome transaction costs and registration bottlenecks associated with CDM project implementation.

The advantages of adopting a PoA approach include:

- Shorter time to market for carbon revenues since the inclusion of an additional small project activity under a registered PoA does not require approval of the CDM project board;
- Scalability, as the PoA does not need to define the geographic location of each project activity in advance;
- Reduced risk of non-registration and therefore increased potential for forward investment; and
- Lower transaction costs than stand alone project activities[19].

As of August 2011, 20 of the 84 PoAs in the CDM pipeline were located in Africa[20], illustrating the relative success of the model in the region. This is likely to reflect the prevalence of certain project types such as cook stoves and low energy light bulbs which are much needed in Africa and best undertaken as PoAs.

[17] For more information please the CSA page on the PwC sustainability and climate change website: www.pwc.co.uk/eng/services/sustainability_main.html
[18] Although CDM methodologies do also exist for rice management and inorganic fertiliser mangement
[19] www.southpolecarbon.com/_downloads/PoA_Guidebook_SouthPole.pdf
[20] www.enviroscope.iges.or.jp/modules/envirolib/upload/2656/attach/iges_cdm_poa_db_e.zip

Compliance trading schemes

Compliance trading schemes exist at regional, national and sub-national levels. The eligibility of credits from carbon projects in compliance trading schemes is determined by scheme rules.

The EU ETS covers approximately 11,000 installations across Europe and around half the EU's GHG emissions. It has historically dominated the carbon markets in terms of traded value and liquidity; in 2010 the traded volumes in the EU ETS totalled $119.8 billion or over 84% of the total global carbon markets[21].

In the initial phases of the EU ETS (2005 – 2012) companies have received a free allocation of EU allowances and are obliged to surrender each year an equivalent number of allowances to match their CO2 emissions. Subject to certain limits, installations may also use credits generated by the project based mechanisms, although CERs from LULUCF activities are not eligible. The main source of demand in the global carbon market therefore currently restricts use of credits generated from carbon sequestration in trees and soils.

New Zealand has an operational, economy-wide emissions trading scheme. Although the scheme covers all sectors, individual sectors' inclusion is staggered: the scheme has included the forestry sector since 2008, and stationary energy and industrial process since July 1, 2010. The agriculture sector was expected to be covered by 2015, however the government recently announced that full implementation could be delayed if adequate progress is not made in establishing similar regulations in other developed countries. Whilst participants in the scheme can surrender an unlimited number of CERs for compliance purposes, the temporary CERs generated from A/R projects are ineligible[22]. The opportunity for CSA activities in Sub-Saharan Africa to access capital directly through the NZ ETS is therefore extremely limited in the short-term.

At a sub-national level, Alberta's offset credit system is a compliance mechanism for entities regulated under the province's mandatory GHG emission intensity-based regulatory system[23]. Soil carbon credits are eligible under the scheme, however these must originate from projects located within the state.

There are also a number of proposed emissions trading schemes which are expected to commence in the next few years. California's emissions trading scheme is expected to start in 2013 and Australia's recently announced carbon reduction plans will include an emissions trading scheme which will commence in 2015. Whilst the details of such schemes are still to be confirmed in law it is expected that, as with the EU ETS, the importation of credits will be limited to permanent internationally recognised units (i.e. CERs excluding afforestation and reforestation projects), up to a pre-determined cap. The ability for a large portion of CSA project types (i.e. those based on sequestration in trees and soils) in Sub-Saharan Africa to benefit from these markets therefore again appears extremely limited in the short run.

[21] World Bank, 2011. State and trends of the carbon markets.
[22] www.mfe.govt.nz/publications/climate/emissions-factsheets/factsheet-27.html. Accessed 21 July 2011
[23] www.co2offsetresearch.org/policy/Alberta.html

The voluntary carbon market

Outside of the regulated markets a voluntary carbon market has emerged. This market represents an active demand by businesses and individuals for some form of action on climate change in the absence of direct regulation. Offset credits are used in an increasing range of applications including point-of-purchase programmes for consumers (e.g. airline tickets, credit cards, holidays or vehicle purchases) or to underpin statements of carbon neutrality in everything from corporate annual reports to rock concerts.

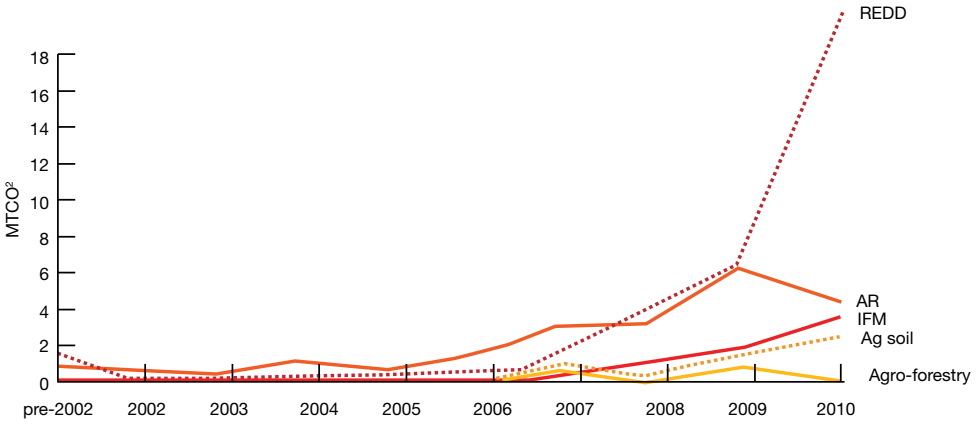
The purchase of offset credits has also been used as an early hedge against future carbon regulation, most notably the expected emissions regulation in California which many expect to allow, at least in the short term, credits generated under a number of voluntary standards. However only projects located in the USA (and possibly the states of Acre in Brazil, and Chiapas in Mexico) are expected to be eligible, therefore excluding projects in Sub-Saharan Africa.

The voluntary carbon market is much smaller than either the EU ETS or CDM market; in 2010 the total value of credits in the voluntary market was around $338m, less than 1% of the total global carbon markets. Carbon credit prices are also lower than in the compliance markets – the average 2010 price was around USD 6/tCO2e[24], compared to around USD 17.40/tCO2e for a CER[25].

Despite lower volumes and values compared to the compliance markets, the voluntary carbon market has often been a source of innovation, piloting new project activities and approaches. Unlike the compliance markets, credits from LULUCF projects have long played a role in the voluntary carbon market, and in 2010 land-based projects supplied almost half (45%) of transacted credits[26]. As shown in Figure 2, this is largely due to the rise in prominence of credits from projects which reduce emissions from deforestation and degradation (REDD). Credits from CSA activities such as agro-forestry and nitrogen management still make only a very limited contribution. Sub-Saharan Africa has also yet to benefit significantly from the voluntary carbon market; projects based in Africa as a whole accounted for just 4% of the 2010 market[27].

The voluntary carbon market has often been a source of innovation, piloting new project activities and approaches

Figure 2: Historic transaction volumes, forestry and other land use types[28]



[24] Bloomberg New Energy Finance, Ecosystem Marketplace, 2011. Back to the Future: State of the Voluntary Carbon Markets 2011.
[25] www.icis.com/heren/articles/2010/12/24/9422349/emissions/edcm/the-year-in-numbers.html. Accessed 21 July 2011.
[26] Bloomberg New Energy Finance, Ecosystem Marketplace, 2011. Back to the Future: State of the Voluntary Carbon Markets 2011.
[27] ibid
[28] ibid

Part two: Overview of agricultural carbon markets and methodologies

CSA related carbon methodologies existing under voluntary carbon standards

Under voluntary carbon standards there is a greater variety of methodologies (than in compliance markets) that have potential to support CSA practices with multiple benefits for smallholders in Sub-Saharan Africa. This review found 36 methodologies in this category which have either been approved or are under development across the major voluntary carbon market standards, which include: the Verified Carbon Standard (VCS); Plan Vivo; the Gold Standard (GS); the American Carbon Registry (ACR); and Carbon Fix (CF).

Given the broader scope of eligible activity types within the voluntary carbon market, the list of approved methodologies supports a broader range of CSA practices including:

- Watershed restoration: either directly through REDD and A/R activities, or indirectly through integrated farm energy systems / energy efficiency activities that could relieve non-renewable firewood collection pressures;
- Agroforestry: including boundary planting, fruit orchard establishment, dispersed inter-planting of N-fixing species and woodlot establishment;
- Integrated farm energy systems;
- Nutrient management activities: including reduction of inorganic N-fertiliser use; and
- Rice system management.

If all methodologies currently under or awaiting assessment are approved, this list could be expanded to include:

- Pasture and grazing land management: including emission reductions achieved through soil carbon sequestration and fire management activities;
- Nutrient management: including forms of manure management to improve soil quality; and
- Tillage and residue management: including emission reductions achieved through soil carbon sequestration.

Furthermore, due to the broader scope of land-based mitigation activities permitted in the voluntary carbon market, a larger proportion of the methodologies reviewed could be applied to deliver significant adaptation and productivity benefits to smallholder farmers in Sub-Saharan Africa.

Perspectives of CSA project developers in Sub-Saharan Africa

Whilst a greater range of relevant carbon methodologies exist under voluntary carbon standards, other barriers continue to restrict CSA project developers from accessing carbon market opportunities. Through discussions with project developers based in Sub-Saharan Africa, it was ascertained that key barriers include:

- A lack of carbon methodologies covering the full scope of CSA practice types under a landscape approach, especially with regard to soil carbon;
- Existing carbon methodologies remain inflexible and are technically very demanding. This leads to an over reliance on external consultants for support in establishing projects, and an inability to scale implementation effectively;
- Voluntary carbon market prices have been in a state of decline in recent years. At current prices the economics of carbon project development are challenging. Project developers report that carbon market revenues are insufficient to cover the full costs of project establishment, of which a critical component is extension service delivery;
- Non-permanence risk buffers for CSA are too high. This proves particularly restrictive in the early years of project implementation when carbon revenues are most needed;
- MRV requirements are technically complex. Trade-off exists between meeting the requirements for accuracy of data and maintaining project profitability;
- Market demand for different credit types (e.g. ex-ante versus ex-post) under different standards is hard to ascertain;
- There is a lack of research to quantify the correlation between certain types of smallholder CSA practices and emissions reductions, inhibiting use of activity based monitoring approaches. This is especially the case for quantification of soil carbon benefits; and
- There is a lack of guidance on effective carbon market revenue sharing arrangements.

Project developers also identified the following critical success factors to CSA project development:

- Availability of funding to support ongoing operating costs such as extension service provision, and project establishment costs and associated consultancy fees;
- Appropriate community governance structures with equal gender representation at the decision making level. This helps ensure the project remain focused on meeting smallholder needs and enables more effective communication between project developers and smallholder participants;
- Multi-stakeholder partnerships bringing together complimentary technical and financial experience;
- Smallholder access to high quality farm inputs (such as seeds, tools and fertiliser) and credit facilities;
- High quality extension service delivery; and
- Organisation of farmers into 'self help groups' or 'farmer clubs' of between 10-20 members. This provides a 'human infrastructure' through which to provide extension services and to facilitate participatory learning techniques.

Part three: Review of voluntary carbon standards

In the absence of regulation to underpin the integrity of credits within the voluntary carbon market, a series of voluntary, independent, third-party verified standards have emerged. Voluntary carbon standards outline the main design parameters that a project must adhere to in order to generate voluntary carbon credits[29]. Voluntary carbon standards now stand behind 90% of transacted credits in the voluntary carbon market[30].

A standard provides guidelines for project developers across some or all of the following:

- Eligibility of mitigation activity types;
- Assessment of project additionality;
- Quantification of mitigation benefits;
- Requirements for environmental and social safeguards (and co-benefit delivery);
- Requirements for monitoring, reporting and verification of project performance;
- Requirements for bundling project activities;
- Third party validation and verification requirements and processes;
- Non-permanence risk quantification and mitigation mechanisms; and
- Registration and enforcement systems.

Whilst individual standards have been developed to support specific activity types and objectives, voluntary carbon standards can be broadly categorised into two groups:

- **Primary standards** used to ensure a project is delivering real and long lasting emission reductions against a business as usual scenario.
- **Secondary standards** typically used to certify the strong social and environmental co-benefits delivered in addition to emission reductions.

The importance of secondary standards in the context of CSA

For CSA project activities to be successful, first and foremost projects need to deliver significant adaptation and productivity benefits to smallholders as these invariably outweigh the benefits of mitigation from the perspective of the smallholder. With this primary focus in mind, the mitigation effects should be viewed as the 'co-benefits' of these project types from the point of view of the smallholder. In some instances trade-offs will exist between the level of mitigation potential CSA activities and the level of livelihood and adaptation benefits that can be realised. The importance of secondary standards in highlighting these aims is therefore more significant for CSA than other carbon project types.

Through conversations with project developers, voluntary carbon market standard setters, and project donors and investors, the following advantages of secondary standards were identified:

- Acting as a 'quality assurance' signal to investors and donors that the project is orientated around sustainable objectives;
- Acting as a risk management mechanism for investors and offset buyers, who seek assurance that they are not involved with a project that has negative social or biodiversity impacts, and thus supporting market access;
- Commanding a price premium, enhancing economic viability of project implementation[31];
- Enabling finance flows from donors and investors who are motivated to support projects with multiple benefits including adaptation, development, and poverty reduction, as well as 'carbon positive' impacts; and
- Providing project developers with an implementation framework to improve communication channels with participating smallholders, enhancing effectiveness of project implementation.

[29] Voluntary carbon credits are generally referred to as Verified Emission Reductions (VERs) with each representing a tCO2 eq.
[30] Bloomberg New Energy Finance, Ecosystem Marketplace, 2011. Back to the Future: State of the Voluntary Carbon Markets 2011.
[31] However it should be noted that use of secondary standards increases validation and verification costs and this will have to be balanced against potential premium in carbon revenue.

Standards: who is leading the pack?

In 2010, the Verified Carbon Standard (VCS) had the largest market share (42%) of voluntary carbon markets (transacting 27.7 MtCO2e). A key driver for this position was the emergence of several approved REDD+ VCS methodologies which allowed several large REDD+ projects that had been waiting in the wings to issue credits.

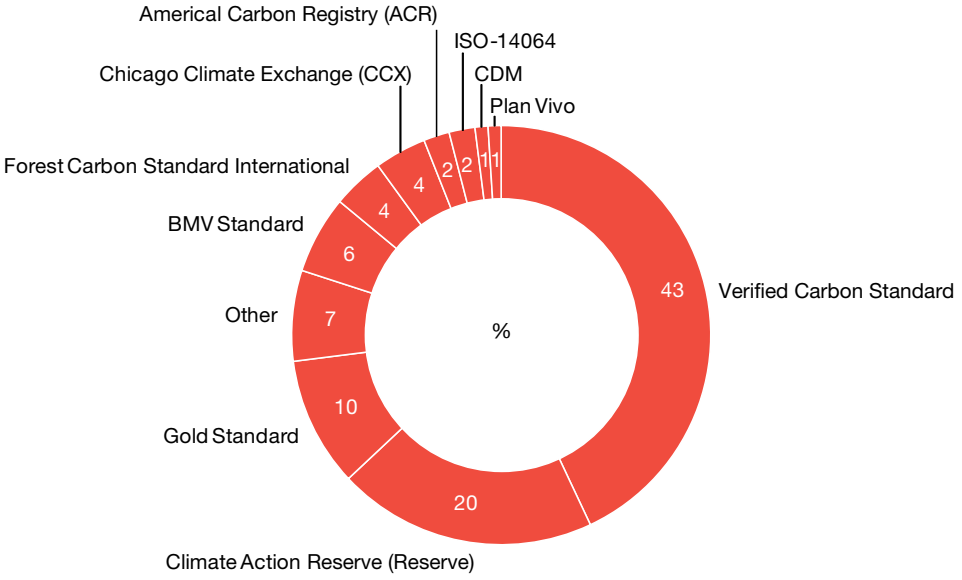
The Climate Action Reserve (CAR) is primarily aimed at US carbon projects. In 2010, projects using CAR protocols transacted the second-largest volumes in the voluntary market and only 1 MtCO2e less than the previous year[32].

The Gold Standard also transacted record volumes (6.4 MtCO2e).

Two new forestry specific standards emerged in 2010: the BMV Standard and the Forest Carbon Standard International, with both transacting large volumes in their first year on the market. The BMV Standard for REDD+ is tailored to Brazilian projects and Latin American buyers, while the Forest Carbon Standard International was reported to have appealed to US-based voluntary buyers with its support of Improved Forest Management (IFM) activities[33].

Amidst last year's rapidly changing market dynamics, a few standards lost market share. The American Carbon Registry was focussed on establishing new methodologies in 2010 and, in addition to tougher competition, lost market share as a consequence. New methodologies either being developed or now approved include those for commercial timberlands IFM, N_2O reductions from fertilizer management and in 2011, their first international methodology for REDD+ projects.

Figure 3: 2011 market shares of primary voluntary carbon market standards[34]



[32] Bloomberg New Energy Finance, Ecosystem Marketplace, 2011. Back to the Future: State of the Voluntary Carbon Markets 2011.
[33] ibid
[34] PwC based on Bloomberg New Energy Finance, Ecosystem Marketplace, 2011. Back to the Future: State of the Voluntary Carbon Markets 2011. Note: Of the two main secondary standards, the Climate Community and Biodiversity Standard (CCB) was reportedly used for 19% of credits, whilst the SOCIALCARBON standard reached 1% in 2011.

Voluntary carbon standards selected for review

Table 2: Primary and secondary standards selected for evaluation

1. Primary standards	2. Secondary standards
• American Carbon Registry	• CCB
• Carbon Fix	• SOCIALCARBON
• CDM	
• VCS	
• Gold Standard ⟷	• Gold Standard
• Plan Vivo ⟷	• Plan Vivo

The principal criterion for selection of these standards was whether the eligible geographic scope for project implementation under each included Sub-Saharan Africa. For this reason the Climate Action Reserve was not considered for evaluation despite its significant share of the voluntary carbon market. The CDM, whilst not a voluntary carbon market standard itself, was included for evaluation in recognition that CERs are transacted in the voluntary carbon market, and that CDM methodologies can be used by project developers under several of the voluntary carbon market standards. The Gold Standard and Plan Vivo were categorised as primary standards for this analysis as both include carbon accounting methodologies. However both standards also fulfil the role of secondary carbon market standards, requiring projects to deliver ecological and social co-benefits.

Criteria for review

Through conversations with voluntary market carbon credit buyers and project developers, the following key criteria for voluntary market standards were identified:

Table 3: Key criteria for voluntary carbon market standards

Perspective	Criteria	Justification
Credit buyer	• Require independent third party validation and verification	• Provides investors and donors with confidence
Credit buyer	• Effective non-permanence risk mitigation mechanism in place	• Provides investors and donors with confidence
Credit buyer	• Ex-post credit issuance	• Ensures environmental integrity of credits
Project developer	• Mechanism in place for aggregation of individual projects under one programme	• Reduces transaction costs • Supports landscape approach • Enables project to expand as capacity is developed
Project developer	• High demand for credits	• Enhances economic viability of project development
Project developer	• High price for credits	• Enhances economic viability of project development
Project developer	• Broad scope of CSA related mitigation activities eligible, including soil carbon	• Soil carbon sequestration associated with significant adaptation and productivity co-benefits to smallholders
Project developer	• Simplified processes for emissions baseline quantification and MRV data requirements	• Heavy data requirements increase MRV costs, and require high technical capacity of project developers.
Project developer	• Recognises adaptation and productivity co-benefits	• Provides investors and donors with confidence • Enhances marketability of credits

Each of the selected standards was assessed against these key criteria through interviews and literature review.

Findings: Primary carbon standards

American Carbon Registry (ACR)

The ACR has prioritized AFOLU as a means to incentivize large-scale emission reduction opportunities that can simultaneously alleviate poverty, enhance food security, and mitigate the impacts of climate change on the world's poorest populations. The full scope of CSA related activities are eligible under the ACR. However utilisation of the standard by project developers in Sub-Saharan Africa has been limited by the lack of published methodologies relevant to smallholder CSA activities.

ACR has two methodologies – one published in 2010, and one under review for publication in 2011 – related to improving nitrogen use efficiency. Both are applicable worldwide; the methodology still under review focuses on fertilizer rate reduction so is not likely to be appropriate for CSA in Sub-Saharan Africa, while the published ACR fertilizer methodology allows multiple fertilizer management changes that can be implemented to improve nitrogen use efficiency while maintaining yield, so may be applicable (though has heavy requirements for farmer records that would likely need to be streamlined for the Sub-Saharan African smallholder context). ACR has a published methodology for Afforestation/Reforestation of Degraded Lands, with two projects in Africa registered under this methodology, focused on community-based agroforestry and combining tree crops (cashew plantations) with carbon credits; and a published methodology for replacing non-renewable biomass with renewable fuels, with one Africa project registered. Finally ACR has started developing a grazing land methodology which will include enteric emissions, manure management, fertiliser management and soil carbon. To date no approved methodology exists for soil carbon management activities under the standard.

However the ACR is keen to support CSA project types in Africa, and is open to further development of new methodologies under the standard.

In 2010 the ACR commanded 2% of the voluntary market with a reported volume weighted average 2010 credit price of USD 2. This relatively low price was a consequence of large numbers of landfill and industrial project credits being traded at discounted prices. For forestry project credits traded under the standard, prices have been in the range of USD 5-12; CSA credits with environmental and poverty alleviation benefits may command a similar price. All credits are issued on an ex-post basis following verification by an approved third party. Land use credit types are subject to depositing a percentage of credits in a risk buffer account held by the registry to mitigate non-permanence risk, except in the case of land use projects that avoid emissions of N2O and/or CH4 and thus have no non-permanence risk.

The ACR has put in place processes to streamline the approval process of new methodologies. In addition the ACR has developed guidelines for project aggregation which function in a similar manner to CDM PoA. ACR is supporting the development of poverty alleviation indicators for AFOLU project types to be implemented in China under the Panda Standard, and recognises that an adaptation of such indicators could support CSA projects in monitoring the broader non-carbon benefits of their interventions.

Carbon Fix (CF)

CF currently supports the development of A/R activities only. The standard employs a single methodology which is applicable to a broad range of A/R activity types, and has been designed to be user friendly in adoption. CF recently submitted their methodology for approval under the CDM. A decision has not yet been made.

In 2010 CF had less than 1% of the voluntary market share and a reported volume weighted average credit price of approximately USD 16. The relatively high price for CF credits can be explained by retail level transactions made directly by project developers. Wholesale prices for CF credits appear to be in the region of USD 10-13. Under the standard credits can be transacted ex-ante, ex-post forward, and/or ex-post basis following validation by an approved third party. This provides flexibility to project developers in project financing. 20% of credits are deposited in a CF buffer fund, and a further 10% deposited in a project specific buffer fund to address non-permanence risk.

CF has recently been accepted as an eligible standard by ICROA members which potentially presents a precedent for the acceptance by ICROA members of ex-ante crediting. This could open up other ex-ante standards, such as PV (see below) to acceptance by ICROA and more broadly.

Gold Standard (GS)

To date the GS has applied to energy related projects only. As such the scope of its application to CSA activity types is limited to integrated farm energy systems, such as household biogas, biodiesel, and household / on-farm energy efficiency activities. Whilst these project types can indirectly reduce deforestation pressure on watershed areas, they otherwise have limited adaptation and on-farm productivity benefits for smallholder farmers. We understand that GS are currently considering expanding the scope of eligible activities to potentially include land use activities and also composting, however this is at an early phase. The GS expressed a willingness to better understand how CSA practices could potentially be included and may be of great relevance in the future.

The GS can be applied to both CDM and voluntary market project types. Projects developed under the GS are required to make net-positive contributions to the economic, environmental and social welfare of the local population. As such project developers are typically able to command a premium price for their credits. In 2010 the GS held an 8% voluntary market share with a reported volume weighted average credit price of USD 11 (although prices ranged

between USD 5-35). Projects can be developed as PoAs under the GS.

Plan Vivo (PV)

PV is specifically focused on smallholder and community based land use projects (A/R, agroforestry and REDD+) in developing countries. To date PV do not have projects that quantifiy the carbon benefits from improved agricultural practices beyond increasing tree biomass on farms. However the standard has consulted its stakeholders and plans to widen the range of CSA activities that lead to verifiable carbon benefits, and will facilitate the development of new methodologies to support this process.

The Plan Vivo System only verifies credits that come from practices that are undertaken by smallholder farmers and community groups, and that are designed using a bottom up approach to address the specific needs of participants in specific regions. This includes development of MRV systems that can be supported through farmer self assessment, reducing associated knowledge and transaction cost barriers. Carbon benefit quantification in the Plan Vivo system is achieved through the development of technical specifications that describe baseline and project scenarios for defined systems across the region to which they are applicable. This standardisation at the programme level allows projects to rapidly and cost effectively expand within the region. For example participation in Trees for Global Benefits Project in Uganda has grown from an initial 30 farmers to over 1000 today. PV encourages the development of technical specifications with broad applicability that could be adopted by project developers across larger areas of Sub-Saharan Africa, and include additional activity types such as soil carbon management.

In 2010 PV credits represented less than 1% of the voluntary carbon market with a volume weighted credit price of USD 8. PV currently has seven registered projects globally (of which four are in Sub-Saharan Africa) and more projects are in the pipeline. Over 1 million PV certificates have been issued to date [35]. PV credits have been bought by large CSR corporate buyers in the past and PV reports a track record of repeat purchases. PV offers project developers the option of ex-ante issuance of credits recognising that upfront finance is a key barrier preventing smallholder farmers from transitioning towards CSA practices. In this sense ex-ante credits contribute to overcoming genuine additionality barriers. However the question of non-permanence risk associated with ex-ante issuance remains an issue for many potential buyers of PV credits with who we discussed the standard. To help address this risk, projects are typically required to keep 10-20% of credits unsold. Project developers also reported issues related to the successful marketing of issued PV credits.

Verified Carbon Standard (VCS)

The full scope of CSA related activities are eligible for crediting under the VCS. The VCS has a track record of supporting pioneering AFOLU project approaches that demonstrate a proof of concept that land use credits can be fully fungible with other credit types. The VCS has approved several REDD+ methodologies with high applicability to the Sub-Saharan Africa region. In addition the VCS has five soil carbon methodologies awaiting approval. Of these, the Sustainable Agricultural Land Management (SALM) methodology has been applied to the Kenyan Agricultural Carbon Project in Western Kenya, which recently announced, with the World Bank Biocarbon Fund, the first ERPA agreement for soil carbon credits. The VCS also allows for the development of AFOLU methodologies specifically designed to support a 'grouped project' approach. As with the CDM PoA, this approach could support large numbers of project activities under a programmatic approach, and thus enable landscape scale CSA activities.

Another initiative being developed under the VCS are 'standardised approaches' which could be applied in the development of baseline and additionality assessments. Such approaches aim to remove some of the technical burden associated with PDD development from project developers, and shift this instead to methodology developers. The potential combination of 'standardised approaches' and 'grouped project' activities could remove some of the significant barriers restricting CSA project development, and in turn provide a blueprint for future NAMA CSA activities. Final guidelines for 'standardised approaches' under the VCS are due in early 2012.

In 2010 the VCS commanded a 42% share of the voluntary carbon market. The volume weighted average credit price was approximately USD 5, with prices for AFOLU credit types marginally higher at approximately USD 8. All credits are issued ex-post under the VCS following validation and verification by an approved third party. Land use projects are required to deposit a percentage of issued credits in a pooled AFOLU buffer account. The percentage deposited is determined based on project specific risk profile but typically varies between 15-50% depending on project specific risk factors.

Clean Development Mechanism (CDM)

In 2010, CDM activity in the voluntary market (as opposed to through the compliance markets) accounted for 1% of the market share at a volume weighted credit price of USD 10. The strengths and limitations of the CDM vis-a-vis CSA are set out in Part 2.

[35] Compared to approximately 4.6 million AFOLU credits issued under the VCS.

Findings: Secondary market standards

Community Climate and Biodiversity (CCB) standards

The CCB standards were developed specifically to address the social and environmental risks and opportunities of land management projects. This makes the standards of particular relevance to CSA. Adherence with the standards provides a safeguard against the social and environmental risks of land management project implementation such as involuntary resettlement, respecting indigenous peoples and local communities customary and statutory rights to lands, territories and resources. It also acts as a verification tool to credit buyers that project developer's claims of co-benefit generation are justified.

The CCB standards certified the second-largest volume of credits transacted in 2010 – up from 1 MtCO2e in 2009 to 15.5 MtCO2e in 2010 (19% of the market) and achieved a volume weighted credit price of USD 4-5. Because the CCB standards do not quantify carbon reductions, they are often 'stacked' with a carbon standard – primarily VCS [36]– to certify projects' additional social and environmental contributions. However, some REDD+ project developers have sought CCB certification in advance of validation under the VCS.

The CCB standards provide project developers with a checklist of actions that must be completed to ensure net positive impacts are achieved on the local ecological conditions and socio-economic welfare of impacted communities. Optional 'gold level' criteria have been added to the standard, against which projects can be assessed for: climate change adaptation benefits; exceptional biodiversity benefits; and exceptional community benefits.

CCB are considering development of a module specifically for projects involving the aggregation of smallholders. Accreditation under such a module could be used to signal to investors that appropriate conditions are in place for successful implementation of the project, overcoming requirements for additional due diligence checks.

SOCIALCARBON

The SOCIALCARBON standard is a secondary standard applicable to any project type. To date the standard has been applied to a range of CSA related projects including smallholder agroforestry, community REDD initiatives and smallholder manure management projects. Despite having global application, the SOCIALCARBON standard is yet to be applied in Africa. The standard relies on carbon benefits of projects being quantified by methodologies from other standards. All certified projects to date have applied the standard in conjunction with the VCS. However project developers are free to use other primary standard methodologies if they wish.

In 2010 the SOCIALCARBON standard had been applied to 1% of credits transacted in the voluntary carbon market. The reported credit price transacted was approximately USD 6-7. According to the standard, application enables project developers to achieve 30-80% premiums on the price of their credits. In some instances donors and private sector investors have provided ongoing funding to SOCIALCARBON accredited projects based solely on performance against socio-economic indicators, without issuance of carbon credits.

The SOCIALCARBON standard builds on the FAO's sustainable livelihood methodology. It allows project developers freedom to identify project specific performance metrics across the following 6 sustainability aspects: biodiversity, human, natural, social, carbon and financial. For a project to maintain accreditation it must demonstrate ongoing progress against each of these aspects. The flexibility of this bottom up approach provides project developer s with a usable framework around which to develop associated MRV systems and evaluate holistic progress in implementation.

[36] Project developers also combined use of the CCB with additional standards including: CDM, Carbon Fix, Plan Vivo and ISO 140064.

Conclusions

Public funding alone cannot address the scale of the climate-smart agriculture challenge. Carbon markets have the potential to leverage private investment for CSA projects and to generate incremental revenues to support the scaling of CSA activities. But carbon markets are not homogenous. The carbon market is made up of a number of different parts including: project based mechanisms established under the Kyoto Protocol, in particular the CDM; regional emissions trading schemes such as the EU ETS; and the voluntary carbon market. The extent to which different markets are able to support CSA depends on the eligibility criteria, the existence of appropriate methodologies, market prices and demand for credits.

To date the focus of the CDM, on industrial and energy sectors, has been a challenge for Sub-Saharan Africa and thus for CSA. Key CSA related activity types including agricultural soil carbon management and REDD remain ineligible under the CDM. And although afforestation and reforestation (A/R) activities, including agroforestry, are eligible, these projects are awarded temporary credits that have limited fungibility with other traded carbon credits. Opportunities in the EU ETS are even more limited as credits from A/R projects are ineligible. Opportunities for use of international land use credits under future schemes in Australia and California also look to be limited in the short run. And whilst the voluntary carbon market currently has broader applicability to smallholder CSA in Sub-Saharan Africa, the voluntary carbon market is much smaller than the CDM market and credits are generally worth less.

Of the various standards currently used within the carbon market, no one standard meets all of the criteria of broad eligibility of CSA practices; investor demand; value of credits; strong reputation for environmental integrity of credits; and a pragmatic approach to project developer needs. This creates a dilemma for project developers who face trade-offs, notably between the volume and value of credits and the costs and complexities of managing projects.

"no one standard meets all of the criteria"

Figure 4: Performance of primary carbon standards against key criteria

	VCS	Gold Standard	American Carbon Registry	Plan Vivo	Carbon Fix	CDM
Eligibility of key CSA practices	Higher	Lower	Higher	Higher	Medium	Medium
Investor demand	Higher	Higher	Medium	Medium	Medium	Higher
Value of credits	Medium	Higher	Medium	Medium	Higher	Higher
Market perception of environmental integrity of credits generated	Higher	Higher	Higher	Medium	Medium	Higher
CSA project developers' perception of simplicity*	Lower	Lower	Lower	Higher	Higher	Lower

Higher
Medium
Lower

Recommendations

Due to the low mitigation potential of CSA practices at the individual smallholder level (estimated by the IPCC to lie between -0.79-8.51tCO2 /ha/ year)[37], aggregation and implementation at scale will be necessary if transaction cost barriers are to be overcome. Smallholder projects need approved methodologies that support CSA at scale. In this regard the growing popularity of PoAs and grouped approaches is welcome. Opportunities to further reduce transaction costs for CSA projects should arise from the development of methodologies that apply standardised approaches to establishment of baselines and project emissions, and create 'positive lists' for CSA that can be used for additionality assessment. In addition increased use of activity based monitoring approaches can reduce the complexity and cost of project MRV. However use of such methods relies on there being sufficient regionally specific field research to underpin this approach. These opportunities can help reduce the technical burden of carbon project development, and move it from the project developer to the methodology developer, thereby reducing transaction costs. They also provide a blueprint for NAMAs because of their potential for regional or national application.

Methodologies are also needed which not only mitigate emissions but are compatible with CSA practices relevant to adaptation and productivity. Only a small proportion of existing CDM methodologies (which are also applicable under several voluntary carbon standards) can be applied to CSA practice types that deliver these wider benefits. A greater range of methodologies exist (or are awaiting approval) under voluntary carbon standards that could be applied to smallholder CSA practices. These include: nutrient management; watershed restoration; agroforestry; integrated farm energy systems; pasture and grazing land management; and tillage and residue management. However few methodologies provide the option to include all of these practices in a modular approach, which limits the extent to which a single project can recognise the full range of smallholder activities and integrate accounting of on-farm as well as off-farm carbon pools. More modular methodologies, like SALM, could help increase the extent to which individual projects can recognise a wider range of practices. Given the importance of adaptation and productivity benefits for CSA projects the role of secondary standards which appraise non-carbon benefits of projects appear critical. Recognising these benefits could help to leverage additional climate (and development) finance.

If carbon markets are to fulfil their potential for supporting the scaling up of CSA activities then three changes are needed. First, a wider range of CSA activities need to become eligible in both compliance and voluntary carbon markets. Second, more methodologies are needed that support 'triple-win' CSA practices. And third, the technical burden of carbon project development needs to be reduced. This could be achieved through increasing uptake of programmatic approaches to project development and standardised approaches to baseline and additionality assessment, and increased use of activity based monitoring methods underpinned by regionally specific field research. These changes would help to make carbon markets work for agriculture and could make a substantial contribution to poverty alleviation in the region. However, in the absence of strong demand for carbon credits underpinned by legally binding government commitments to reduce emissions, the potential of CSA will continue to be held back.

[37] Smith et al. 2007. Agriculture. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

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Or visit the CSA page at: www.pwc.co.uk/eng/services/sustainability_main.html

Additional information on the carbon standards reviewed in this paper can be found at the following websites:

- American Carbon Registry: www.americancarbonregistry.org
- Carbon Fix: www.carbonfix.info
- CDM: cdm.unfccc.int
- Verified Carbon Standard: www.v-c-s.org
- Gold Standard: www.cdmgoldstandard.org
- Plan Vivo: www.planvivo.org
- CCB Standards: www.climate-standards.org
- SOCIALCARBON: www.socialcarbon.org

Design: ML3-2011-11-16-0927